ZOOLOGICAL RESEARCH

Evaluating the effect of habitat diversity on the species-area relationship using land-bridge islands in Thousand Island Lake, China

Zhi-Feng DING[1,2], Hui-Jian HU[2], Ping DING[1,*]

[1] *The Key Laboratory of Conservation Biology for Endangered Wildlife of the Ministry of Education, College of Life Sciences, Zhejiang University, Hangzhou* 310058*, China*

[2] *Guangdong Entomological Institute & South China Institute of Endangered Animals*, *Guangzhou* 510260 *China*

DEAR EDITOR:

The species-area relationship (SAR) describes the phenomenon whereby the number of plant and animal species found in an area of wild habitat is strongly correlated with the size of that area. As one of the few ecological laws, the SAR plays a vital role in the design and assessment of biodiversity protection regions (Lomolino et al, 2010; Ladle & Whittaker, 2011).

Increasing area and habitat promote species richness (Triantis et al, 2003) and both these mechanisms have theoretical support. Basically, the notion of area *per se* claims that the effects of area are embodied in the chance of species extinction (Preston, 1960, 1962; MacArthur & Wilson, 1963, 1967). In contrast, the habitat diversity hypothesis states that the highly diversified habitats often found in large patches positively impact species addition (Williams, 1964). Although it remains controversial which mechanism is more important in influencing species richness, some ecologists believe that the area *per se* and habitat diversity are mutually complementary and not mutually exclusive (Triantis et al, 2003).

Land-bridge islands are characterized by well-delineated boundaries, an inhospitable surrounding matrix and relatively homogeneous habitats (Hu et al, 2011). Land-bridge islands are considered excellent models for studying the relationship between area *per se* and habitat diversity. Located in Chun'an County in Zhejiang, eastern China (N29º22′-29º50′, E118º34′-119º15′), Thousand Island Lake is a large man-made lake following dam construction on the Xin'an River in 1959. With a water surface area of approximately 580 km^2, the lake contains 1 078 land-bridge islands larger than 0.25 ha (108 m in water level elevation).

To understand correlations between area *per se* and habitat diversity we used bird data for 41 land-bridge islands in Thousand Island Lake from 2006 to 2009. This data was used to compare the goodness-of-fit of the classical Arrhenius SAR model, and the choros (K) model integrating both area and habitats (Triantis et al, 2003). The canonical power function model ($\log S = \log c \times z \times \log A$, in which S represents the number of species and A is the size of the area; c and z are constants) was used to investigate the effect of area on bird species richness. Choros (K) ($K=H\times A$, in which H represents habitat diversity and A is the area of the study island) was adopted to assess correlations between area and habitat diversity (Zhang et al, 2008; Wang et al, 2010). The classical SAR model can be expressed as:

$$\text{Log}\ (S)=\log\ (c)+z\log\ (A) \qquad (1)$$

and the K model can be expressed as:

$$\text{Log}\ (S)=\log\ (c)+z\log\ (K) \qquad (2)$$

Akaike Information Criterion (AIC) was used to determine the optimum model and the model with the lowest AICc (modification of AIC for small n) was considered better (Burnham & Anderson, 2002). Statistical differences in z values among regression equations were compared by referencing the methods of Zar (1996) $t=(b1-b2)/S_{b1,b2}$ in which $b1$ and $b2$ are both regression coefficients and $S_{b1,b2}$ are standard errors of regression coefficients).

Our results show that the lowest AICc was found in the *SAR* model (Table 1), however, no differences in z values were found between the two models ($P>0.05$). These findings indicate that the Arrhenius SAR model gives a better fit than the K model and there is no effect of habitat diversity on the SAR. This finding is in contrast with that of Triantis et al (2003)

Table1 Comparison of the SAR and choros (K) models

Models	z	Adjusted r2	AICc
(logS-logA)	0.12	0.64	–219.71
(logS-logK)	0.11	0.62	–217.94

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[*]Corresponding author, E-mail: dingping@zju.edu.cn

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in which the *K* model better explained the effect of area and habitat diversity on species richness.

One possible explanation for this discrepancy is that due to the relatively homogeneous habitats on the islands of Thousand Island Lake, insignificant differences in habitat diversity may be all that exists between the largest and smallest islands. Therefore, compared with changes in area, habitat homogeneity is more prominent in Thousand Island Lake and bird richness is strongly correlated with area (Hu et al, 2011; Ding et al, 2013). The weak effect of habitat diversity found in this study may also be the result of different statistical methods. There are various ways to define habitat diversity (Looijen, 1995, 1998); for example, Ricklefs (1979) defines habitat as vegetation coverage in a given area but Whittaker et al (1973) defines habitat as the multidimensional space occupied by plant and animal species. Although the latter definition (with minor improvements) has been widely accepted by ecologists (Krebs, 1988, 1994; Looijen, 1995, 1998), the definition itself is too broad and has been difficult to apply consistently across different studies (Newmark, 1986).

Here, only island area was important when explaining the relationship between area, habitat and species richness. Consequently, eliminating habitat diversity alters the results only subtly and in protection practice, area has the highest authority in maintaining bird richness. Effective evaluation of species biodiversity can be obtained by choosing area as a parameter, and priority protection areas can be determined accordingly. This finding suggests that more attention should be given to large islands with high species richness in Thousand Island Lake (Wang et al, 2010).

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